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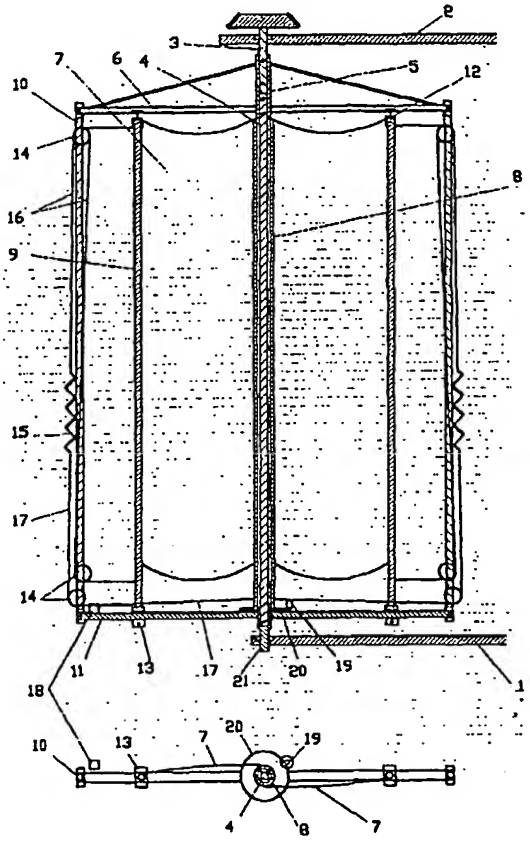
(54) Title: THE PREFAB VARIABLE SURFACE SAIL



(57) Abstract: The Prefab Variable Surface Sail consists of the sail axle (4) seated in the hollow shafts (5) and (21). On the top of the sail is the upper sail slide (6) and on the bottom the lower sail slide (11). The sail axle (4) is inserted into a wider tube which serves as the sail folder (8) and on which the sailcloth (7) is wound. The sail is spread by means of the sail spars (9) running along the upper (6) and lower (11) sail slide. On the sail sides (10) are three pulleys (14) over which the spreading (16) and tightening (17) ropes are running. The sails are spread and contracted by the electric motor (19) which winds and unwinds the sailcloth (7) by rotating the sail folder (8). The electric motor (19) is controlled by an addressable control unit on the windmill base operating upon data received from the wind speed sensor and the sail spread sensors (18). The sails are transported in parts to the site and assembled on the windmill. They are replaceable in case of defect.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

THE PREFAB VARIABLE SURFACE SAIL

Classification of the Invention

This Invention is about the Vertical Shaft Windmill (Patent Registration No. P20000203A), which instead of a centrifugal mechanism for sail surface contraction has a small electric motor mounted on each sail, which, depending on the wind speed, contracts or expands the sail surface. The sail itself consists of prefab parts.

The technical problem

The Vertical Shaft Windmill (Patent Registration No. P20000203A) has a sail expansion-contraction mechanism consisting of the gravitational counterweights which expand the sails at a lighter wind and the centrifugal counterweights which contract the sails at a stronger wind. The problem is that larger windmills tend to rotate at a lower speed, so that the sail folding mechanism cannot be effective. Another problem is that with larger windmills sails are hard to transport not easy to hoist, so that the sails ought to made of more parts for transport and assembly.

State-of-the art

The existing windmills are divided into those with horizontal and vertical shafts. The windmill with rotating sails (Patent Registration No. P20000203A) belongs to the category of vertical shaft windmills and is in fact the only windmill fitted with sails. A sail position control mechanism brings the sails into the optimum position relative to the wind speed. Each sail is fitted with mechanism which expands the sails at a lighter wind and contracts them at a stronger wind. This mechanism consists of gravitational and centrifugal counterweights and appurtenant ropes connecting them mutually and with the sail spars. The centrifugal counterweights expand at stronger winds when the windmill starts rotating faster. With a larger windmill size the number of shaft revolutions is falling, which renders the counterweights ineffective. In the said Patent Registration the sails are shown as a fixed whole which, once assembled, cannot be taken apart, which makes the transport of larger sails impossible.

The essence of the Invention

The primary objective of this Invention is to utilize winds with a speed of 2 m/s or more. The secondary objective is to prevent a breakdown at stronger winds by automatically reducing the sail surface.

The next objective is to make the transport of the sails from the manufacturer's works to the installation site, as well as their on-site assembly, easier.

The advantages of these sails compared with the sails under the Patent Registration No. P20000203A will be shown below.

The Windmill with Rotating Sails has a vertical shaft with three pairs of arms. At the ends of each pair of arms is the bearing of a sail. The three pairs of arms with appurtenant sails are mutually positioned at 120°. On the top of the windmill shaft is a mechanism which at any time places the sails into the best position to the wind. The sails are square-shaped and embrace the wind with a big surface, which allows the windmill to start operating at a wind speed of 2 m/s already. If the wind picks up speed, the sail surface contracts and the windmill is safe in case of a storm, owing to the sail contraction and expansion mechanism fitted to each sail. The mechanism shown in the said Patent Registration (P20000203A) is efficient when it comes to small windmills with small arms having a higher r.p.m. With the increase in the windmill size, however, r.p.m. tends to decrease progressively and the centrifugal counterweights fail to get sufficient centrifugal force required to contract the sails at a stronger wind.

Individual sail parts under the said patent registration can be further disassembled for transport in parts and on-site assembly. Thus the parts are replaceable in case of defect.

With its lower part the sail axle in seated in the bearing – a hollow shaft placed halfway on the lower sail slide. The lower sail slide is a horizontally laid tube or rod which halfway of its length has a short tube welded at the angle of 90° which serves as a shaft of the lower sail slide and which in its upper side accommodates the lower part of the sail axle. This tube and the sail axle are mutually fastened into a firm whole. The lower sail slide shaft is tapered to its lower end and accommodated in the bearing of the lower mill shaft arm.

With its upper part the sail axle is seated in the upper sail slide shaft and also connected with the slide into a firm whole.

The upper sail slide shaft is fastened with a lock to the sail gear shaft. A sail folding tube is mounted on the sail axle. At the bottom of this sail folder is a cogwheel, a sprocket wheel or a pulley-belt by means of which the small electric motor spreads or folds the sails. The folded sailcloth can spread to the left or to the right by means of two sail spars running along the upper and lower sail slide. On the top of the sail spar is the sail spar slide running along the inside of the upper sail slide. This slide is fastened to the sail spar with a lock for easy disconnection if required. Underneath the sail spar has its lower slide, reverse U-shaped, embracing the lower sail slide. At the bottom of this

lower slide spar is a locker which prevents the spar slide to slip from the lower sail slide. This lower spar slide must be at least 20% wider than the lower sail slide so that it can freely run even at freezing winter temperatures.

The sail sides connect the tips of the lower and upper sail slides. At their top and bottom these sail sides have collars which take in the tips of the lower and upper sail slides and which are fastened with a lock into a whole. At the top of the sail sides is one small pulley-belt, two at the bottom. Running over these pulley-belts are two ropes for spreading and one rope for tightening the sails. The sail spreading ropes pull the sail spars to the sail sides and thus spread the sails. At the bottom of the sail folder the sail tightening rope is wound on the folder in a direction counter to that in which the sail is folded, so that the sail is wound when the rope is unwound and vice versa. The sail tightening rope is running over the lowest pulley-belt placed on the sail sides. The sail spreading ropes are attached to a tightening spring at the upper side and the sail tightening ropes at the lower side. Thus the tightening spring connects the ropes into a whole which keeps their sail tightened. The spring is intended to ensure that at a stronger strike the wind only spreads the sail a little without tearing it.

A small electric motor mounted on each sail is rotating the sail folder to one side or the other over a cogwheel, a sprocket wheel or a pulley-belt, thus folding or spreading the sails. The folding operation can reduce the sail surface by 95% of its maximum surface. This protects the windmill from breakdown, so the windmill design can be made less robust, lighter, cheaper and more responsive to gentle winds. The electric motors are connected to energy source through two slide rings on the shaft of the lower sail slide, whereby power is transmitted to the slide brushes. The slide brushes for all three sails are connected to two slide brushes and rings on the windmill shaft through which the electric connection is established to the addressable control unit mounted on or beside the windmill base. Each sail is fitted with a sensor for identifying the degree to which the sails are spread and transmitting the information on to the control unit. The addressable control unit, based on information thus received, and based on sensor-given wind speed information, controls the electric motors, spreading the sails or contracting them. The sail expansion and contraction control is automatically performed and is adjustable on the unit's console. In case of frequently occurring light winds or small consumers the control unit will be set on sail contraction at wind speeds ranging from 6 to 7 m/s. If more wind speed energy utilization is desired, the control unit will be set for the sails to start folding at stronger winds only, i.e., at wind speeds from 10 to 15 m/s.

A brief description of attached Figures

Figure 1 shows the sails in three views: isometric, top-view and side-view. The sketch shows that the sail is mounted between the upper and lower shaft arms. The canvas surface being wound on the sail folder is decreased or increased by the electric motor.

Figure 2 shows the sail spar cross-sections. The upper sail spar slide is inserted on top – whereas below the sail spar has a reverse U-shaped widening serving as the lower sail spar slide. The lower sail spar slide embraces the lower sail slide and runs along it; at its lower side it has a lock to prevent it from slipping. The upper sail spar slide is running along the inside of the upper sail slide, so that it cannot get stuck in freezing winter conditions. The lower sail spar slide must be 20% to 30% wider than the lower sail slide to prevent it from getting stuck in adverse winter conditions.

Figures 3 shows the sail sides. At their upper and lower ends the sides have a ring-shaped widening into which the ends of the upper and lower sail slides and inserted and fixed. On the sail sides are 3 small rope pulleys for spreading and tightening of the sailcloth. One pulley is mounted at the top and two at the bottom of each sail side.

Figures 4 shows the cross-section of the lower sail slide. Placed below this shaft is a sealing ring with two slide rings on which two slide brushes are running.

Detailed description of at least one way in which the Invention operates

As shown in Figure 1, the Windmill with Rotating Sails has a number of parts for assembly.

The upper sail slide (6) at half its length has a hollow shaft (5) for insertion of the sail differential shaft (3), from the upper side, and, from the lower side, the sail shaft (4). The ends of the slide (6) are additionally fixed to the shaft (5) with braces. The lower sail slide (11) at half its length has the lower sail slide shaft (21) which in its upper half is hollow for insertion of the sail shaft (4), as shown in Fig. 1 and Fig. 4. The lower part of the lower sail slide shaft (21) is narrowed and inserted into a bearing placed on the top of the lower shaft arm (1). Placed on this narrowing is a sealing ring (22) with two slide rings (24) on which two slide brushes (23) are running, as shown in Fig. 4.

Placed on the sail axle (4) is a wider tube serving as sail folder (8) onto which the sailcloth (7) is wound. At the bottom of the sail folder is a cogwheel (20) over which the small electric motor (19) is rotating the sail folder (8), thus spreading or contracting the sailcloth (7). The function of the cogwheel (20) can be replaced by that of a pulley-belt or a sprocket wheel. The electric motor (19) is started by the addressable control unit on the windmill base and it receives signals from the wind speed sensor and from the

sensors (18) in each sail it receives data on the degree to which the sails are spread. The control unit starts the electric motor based on the wind speed and sail spread data. Electricity and signals travelling through electric conductors, slide brushes (23) and slide rings (24) reach the electric motor (19). The sliding rings and brushes are mounted at the bottom of each sail and halfway the windmill shaft itself, and that is how electricity and signals are transmitted to the windmill base. The sails spread when the electric motor (19) rotates the sail folder (8) over the cogwheel (20), whereby the wound sailcloth (7) is unwound and the tightening rope (17) wound on the sail folder (8). When winding on the sail folder (8), the tightening rope (17) pulls the tightening spring (15) over a pulley-belt and thereby two sail spreading ropes (16). These ropes (16) are passing over two small pulleys and tightening the sail spars (9), which causes the sailcloth (7) to spread. The tightening spring (15) keeps the ropes and thereby the sailcloth (7) tight. The sail folds in when the electric motor (19) rotates the sail folder (8) in the opposite direction, thus causing the sailcloth (7) to wind on the sail folder (8) and the tightening rope (17) to unwind.

The sail spar (9), Fig. 2, has in the upper part a lock fastened to the upper sail spar slide (12) which with widening is running along the inside of the sail slide (6). In its lower part the sail spar (9) has a welded lower sail spar slide (13), reverse U-shaped, which on the outside embraces the lower sail slide (11) to run along it. A locker at the lower end prevents the lower sail spar slide (13) from slipping from the lower sail slide (11).

The ends of the upper (6) and the lower (11) sail slides are attached to the sail sides (10) which at their upper and lower ends are fitted with rings the inside of which are flush with the outer widths of the ends of the upper and lower sail slides, as shown in Fig. 3. In assembly works the ends of these slides are inserted into the mentioned rings and locked into a whole. The sail side carries three small pulleys (14), one at the top and two at the bottom, over which the ropes are running to spread and contract the sailcloth (7).

Application of the Invention

The Invention of prefab sails, the surface of which is varied by means of electric motors, allows the use of frequent light winds and conversion of wind energy into other forms of energy irrespective of the windmill size.

Owing to the sail folding and spreading mechanism, even large sails can be protected from breakdown in case of stormy weather.

Such larger sails are easy to transport to and assemble on outlying family farms, weekend cottages and similar places without power supply connection.

PATENT CLAIMS

1. The Prefab Variable Surface Sail consists of parts being transported to the site and assembled on the windmill itself, and the whole operation is **characterized in that** it starts with mounting the upper sail slide (6) so that the sail differential gear shaft (3) is inserted from above into the upper part of a hollow tube called the upper sail slide (5) situated half-length of the upper sail slide (6), and the said shafts are interlocked.
2. The Prefab Variable Surface Sail, according to claim 1, is **characterized in that** the sail shaft (4) is placed from below into the upper sail slide shaft (5) and that these shafts are interlocked.
3. The Prefab Variable Surface Sail, according to claim 2, is **characterized in that** the sail shaft (4) is inserted from above into the sail folder (8) with the sailcloth (7) wound on it from its half-length to its edges.
4. The Prefab Variable Surface Sail, according to claim 1, is **characterized in that** the upper sail spar slides (12) are placed into the groove in the upper sail slide (6), the former running freely along the inside of the sail.
5. The Prefab Variable Surface Sail, according to claim 4, is **characterized in that** the upper sail spar slides (12) are carrying the sail spars (9) which are inserted from below into a tubular widening at the lower end of the upper sail spar slides (12) and interlocked.
6. The Prefab Variable Surface Sail, according to claims 3 and 5, is **characterized in that** the sail spars (9) are attached to the sailcloth (7) by gluing or sewing so that the sailcloth (7) unwinds from the sail folder (8) when the sail spar (9) are sliding outwards.
7. The Prefab Variable Surface Sail, according to claim 3, is **characterized in that** at its bottom the sail folder has a fixed cogwheel (20) so that the sail folder rotates with the rotation of its cogwheel (20) the function of which can be replaced by that of a sprocket wheel or a pulley-belt.
8. The Prefab Variable Surface Sail, according to claim 2, is **characterized in that** from its lower side the sail shaft (4) is inserted into the lower sail slide shaft (21) and interlocked.
9. The Prefab Variable Surface Sail, according to claim 8, is **characterized in that** the lower sail slide shaft (21) is tapered below and placed into a bearing at the end of the upper windmill shaft arm (1).

10. The Prefab Variable Surface Sail, according to claims 8 and 9, is **characterized in that** the lower sail slide shaft (21) is situated exactly on the half-length of the lower sail slide (11), welded to it at an angle of 90°.

11. The Prefab Variable Surface Sail, according to claims 5, 6 and 9, is **characterized in that** at their lower end the sail spars (9) have a welded lower sail spar slide (13), reverse U-shaped, which sits on the lower sail slide (11) and which on the inside must be 20% to 30% wider than the lower sail slide (11) in order to be able to freely move in freezing winter conditions.

12. The Prefab Variable Surface Sail, according to claims 1 and 10 is **characterized in that** the upper sail slide (6) and the lower sail slide (11) are attached to the sail sides (10) which together with them form a square; the connection is achieved by means of rings, placed at the ends of the sail sides (10), which take in the ends of the lower sail slide (6) and the ends of the lower sail slide (10), all interlocked.

13. The Prefab Variable Surface Sail, according to claim 12, is **characterized in that** the sail sides (10) have 3 small pulleys (14) mounted on them, one at the top, two at the bottom of the sail side (10).

14. The Prefab Variable Surface Sail, according to claims 5, 6 and 13, is **characterized in that** the sail spars (9) are spread by being pulled by the sail ropes (16), with one rope being attached at the top to the sail holder (9) and passing over the uppermost pulley and fixed to the upper part of the tightening spring (15), the other rope (16) being attached to the lower part of the sail spars (9) and passing over the lower pulley (14) and then over the uppermost pulley (14) whence it also gets fixed to the upper part of the tightening spring (15).

15. The Prefab Variable Surface Sail, according to claims 4, 13 and 14, is **characterized in that** the tightening spring (15) is stretched between the sail spreading ropes (16) and the tightening rope (17) connected with the lower part of the tightening spring (15), passing over the lowest pulley (14) and with the other end wound on the sail folder (8), but in the direction opposite to the winding of the sailcloth (7), to the effect that the tightening rope (17) is winding on the sail folder (8) when the sailcloth (7) is unwinding, and vice versa.

16. The Prefab Variable Surface Sail, according to claims 3 and 7, is **characterized in that** the sail folder (8) is operated over the sail folder cogwheel (21) driven by a small electric motor (19), so that, when rotating to one side, the sailcloth (7) is

winding on the sail folder (8) and unwinding when the electric motor (21) is rotating to the other side.

17. The Prefab Variable Surface Sail, according to claim 16, is **characterized in that** the electric motor (19) is controlled by an addressable control unit on the windmill base which operates upon data received from the wind speed sensor installed beside the windmill and the sail spread sensor (18) mounted on each sail.

18. The Prefab Variable Surface Sail, according to claims 8, 16 and 17, is **characterized in that** the electric motor (19) is power supplied through electric conductors over the slide rings (24) installed in the lower sail slide shaft (21) and over the slide brushes (23) on to such brushes and rings in the windmill shaft to be connected to the addressable control unit; electric signals from the sail spread sensors (18) cover the same path.

19. The Prefab Variable Surface Sail, according to claims 8, 16 and 18, is **characterized in that** the slide rings (24) are isolated from the upper sail slide shaft (21) with a sealing ring (22) which keeps the slide rings fixed and through which the electric conductors lead to the electric motor (19).

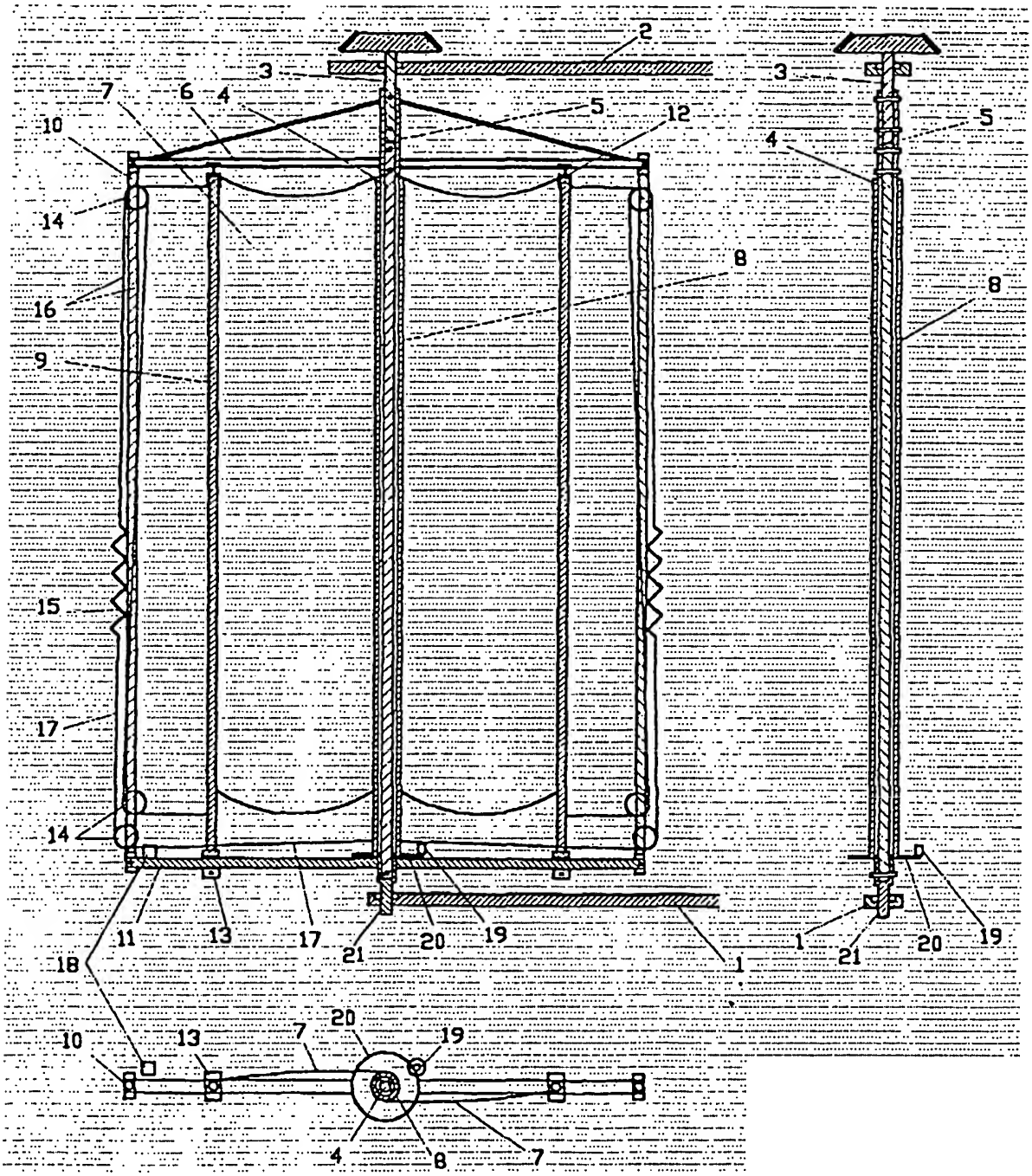
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Fig 1

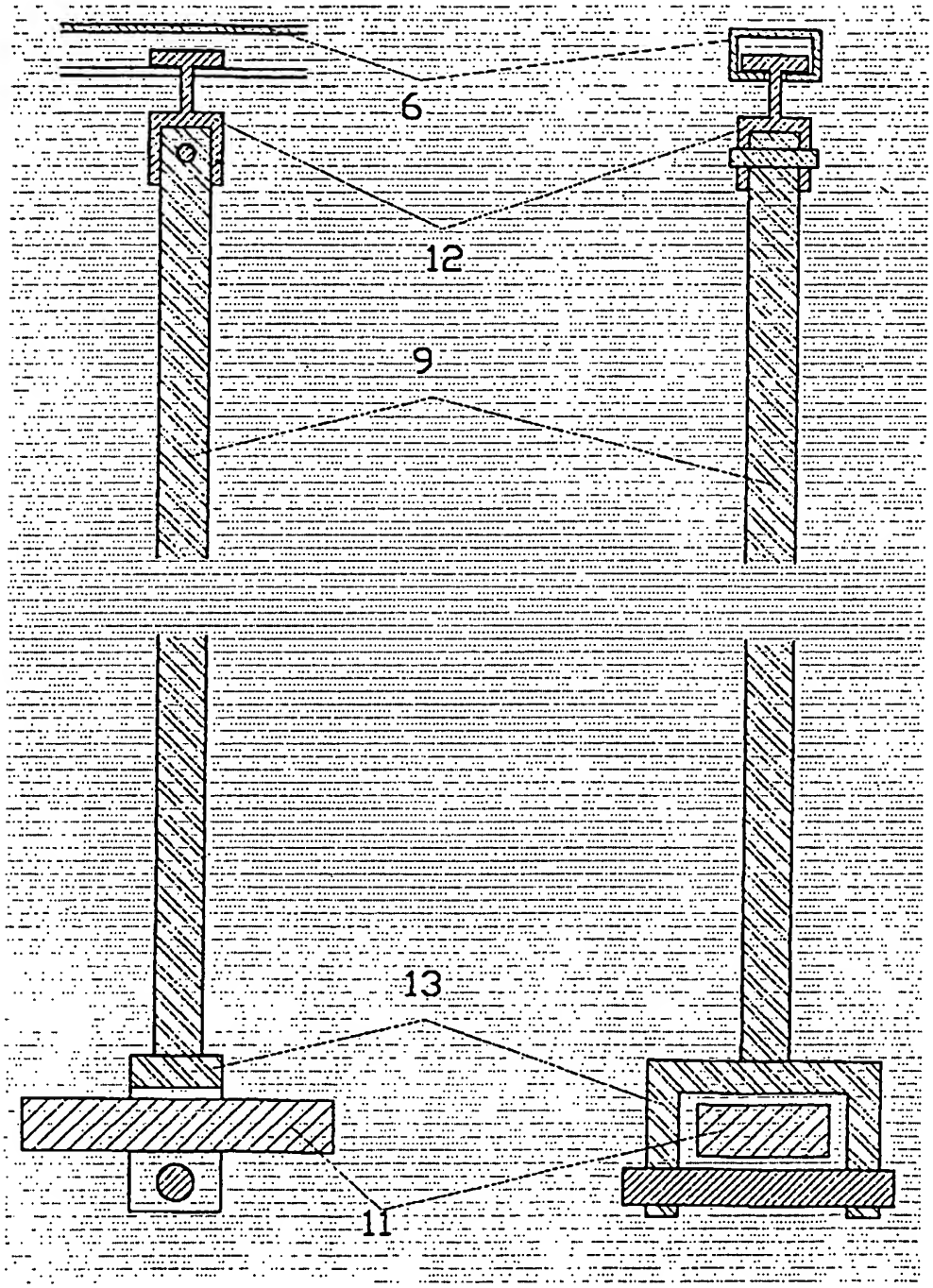

Fig 2

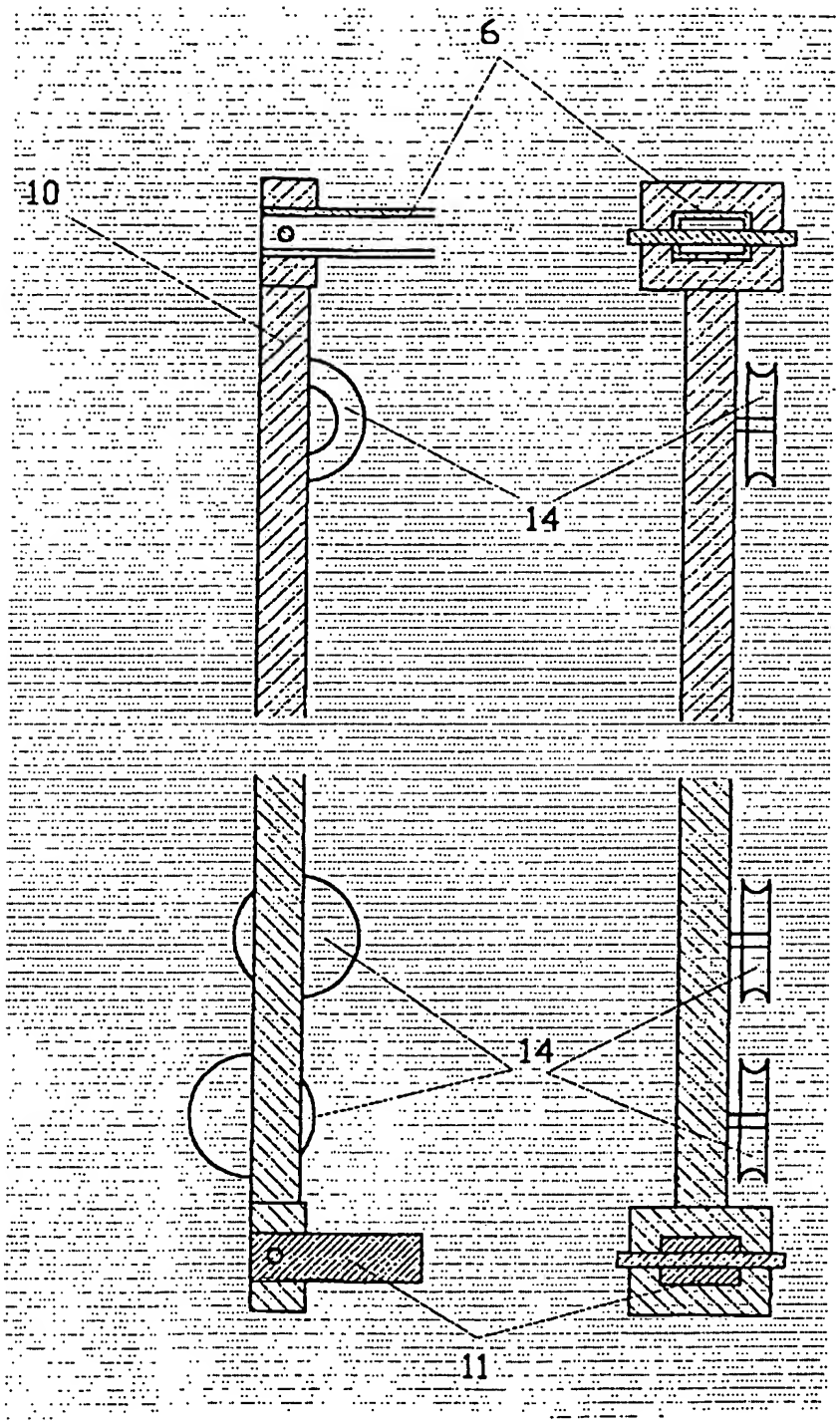

Fig 3

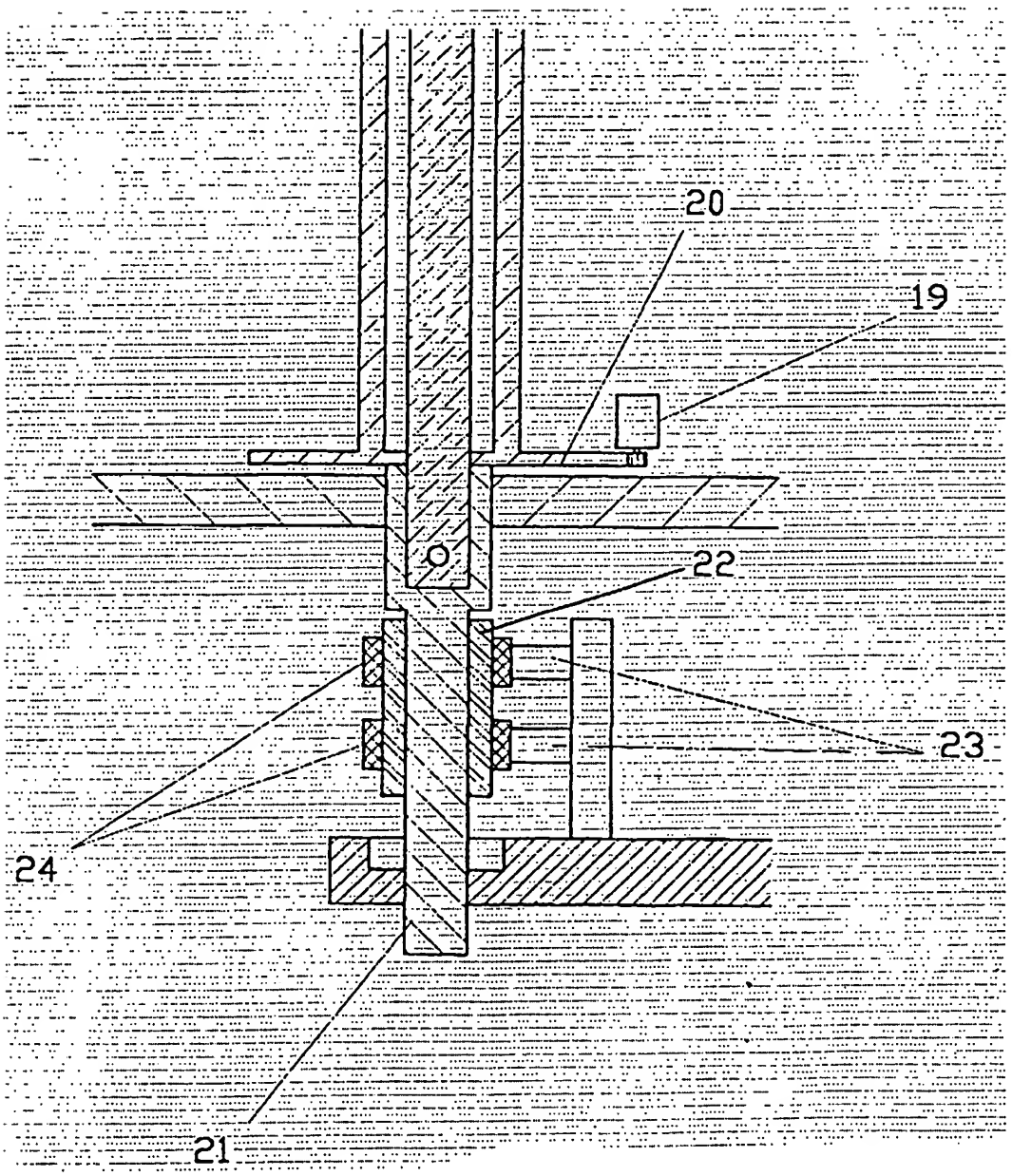

Fig 4

INTERNATIONAL SEARCH REPORT

Inte ıal Application No
PCT/HR 01/00040

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D3/00 F03D7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 454 694 A (O'DELL CLARENCE E) 3 October 1995 (1995-10-03) column 2, line 4; figures 1,3,7-11	1-19
X	US 4 545 729 A (STORM JOE) 8 October 1985 (1985-10-08) figures 4-6	1-19
X	PATENT ABSTRACTS OF JAPAN vol. 004, no. 080 (M-015), 10 June 1980 (1980-06-10) & JP 55 040273 A (TAKAYAMA TOSHIO), 21 March 1980 (1980-03-21) abstract; figure 5	1-19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
18 December 2001	28/12/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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